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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/800,112	03/12/2004	Yuxiang May Wang	008245/DSM/BCVD	8920

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EXAMINER	
DAHIMENE, MAHMOUD	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 10/05/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/800,112	WANG ET AL.	
	Examiner	Art Unit	
	Mahmoud Dahimene	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 16 and 17 recite the limitation "the aluminum layer" in claim 9. There is insufficient antecedent basis for this limitation in the claims.

3. Claims 20 and 21 recite the limitation "the one or more amorphous carbon layers" in 19. There is insufficient antecedent basis for this limitation in the claims.

4. Claim 22 recites the limitation "the generating plasma" in claim 9. There is insufficient antecedent basis for this limitation in the claim since many steps may involve generating a plasma.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1,2,7,8,9,10,16,17,18 are rejected under 35 U.S.C. 102(e) as being anticipated by Rui et al. (US 20040229470).

Rui discloses a method for etching an Aluminum layer using a amorphous carbon mask which reads on a method for processing a substrate in a processing chamber (figure 4), the substrate is a silicon wafer (200) with a film stack (202) (Page 2, paragraph 20). The method comprises the steps of:

(a) Forming a dielectric layer (202) this layer may comprise a barrier layer (Page 2, paragraph 21);

(b) forming an Aluminum conductive material layer (204) on a surface of the substrate (Page 2, paragraph 21) ;

(c) depositing an amorphous carbon layer (206) regarded as a hard mask on the conductive material layer (Page 2, paragraph 24);

(d) depositing an anti-reflective coating (207) on the amorphous carbon layer (Page 2, paragraph 25);

(e) depositing a patterned resist material (208) on the ARC layer (207) (Page 2, paragraphs 26-31);

(f) etching the ARC layer (Page 3, paragraph 32);

(g) removing the resist material prior to etching the Aluminum (Page 3, paragraph 32)

(h) etching the amorphous carbon layer (step 110) to form a patterned amorphous carbon layer (214) (Page 3, paragraph 32) to the conductive material layer;

(i) etching feature definitions in the conductive material layer corresponding to

the patterned amorphous carbon layer(step 116) (Page 3, paragraph 41), and;

(j) removing the amorphous carbon layer by exposing it to a plasma of a hydrogen-containing gas or an oxygen-containing gas (page 4, paragraph 44).

Claim 1 comprises steps b, c, h and i of Rui's reference

As to claims 2, 10 step (b) of Rui includes Aluminum

As to claim 7,18, Rui discloses a metal etch selectivity to the amorphous carbon of 0.1:1 (page 3, paragraph 36) which reads on an etch selectivity of amorphous carbon to the conductive material is between about 1:3 and about 1:10.

As to claim 8, Rui discloses an anti-reflective coating (207) immediately adjacent to the amorphous carbon layer (206) (page 2, paragraph 25).

As to claim 9, it comprises steps b, c, d, e, f, h and i of Rui's reference

As to claim 16, Rui discloses a barrier layer prior to depositing the Aluminum layer(Page 2, paragraph 21).

As to claim 17, Rui discloses removing the resist material prior to etching feature definitions in the Al layer (Page 3, paragraph 32).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 3,4,5,11,12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rui et al. (US 20040229470) as applied to claims 1,2 and 9,10 above, and further in view of Liu et al. (US 20040038537).

The method of Rui, as described above in steps a- j also includes a PECVD (Plasma Enhanced CVD) type chamber which is used to deposit the amorphous carbon layer.

A di fference is noted between the applicant's claims 3,4, 5,11,12,13 and the reference of Rui. Rui is silent about the specific processing gases used in depositing the amorphous carbon layer.

Liu discloses a method for depositing and etching an amorphous carbon layer (108) used as hard mask. The method for forming an amorphous carbon layer on a substrate surface includes: providing a gas mixture to a deposition chamber in which

the substrate surface is positioned, wherein the gas mixture comprises one or more hydrocarbon compounds and an inert gas. Typically, the one or more hydrocarbon compounds in the gas mixture have the general formula C_xH_y, wherein x has a range of 2 to 4 and y has a range of 2 to 10. Some of the hydrocarbon compounds which work well include propylene (C_3H_6), propyne (C_3H_4), propane (C_3H_8), butane (C_4H_{10}), butylene (C_4H_8), butadiene (C_4H_6), or acetylene (C_2H_2) and combinations thereof. Propylene works particularly well (Page 1, paragraph 9). And generating a plasma of the one or hydrocarbon compounds (Page 1, paragraph 11). The gas mixture further comprises an inert gas (Page 1, paragraph 10).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of reference Rui to include hydrocarbon compounds as gases because reference of Liu illustrates that it is conventional to include the gases cited above in semiconductor manufacturing process. One of ordinary skill in the art would have been motivated to use the hydrocarbon compound gases, inert gases and a plasma enhanced deposition because they amount to the essential deposition parameters typically used for amorphous carbon deposition in other applications as well such as optical coating, protective coating, etc.

Claim Rejections - 35 USC § 103

10. Claims 6 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rui et al. (US 20040229470) in view of Liu et al. (US 20040038537) as applied to claims 3,4,5 and 11,12,13 above, and further in view of Lee et al. (US 6043167).

The method of Rui modified by Liu, as described above, is silent about using a dual frequency RF power source for generating the plasma used in the deposition of the amorphous layer.

Lee discloses a method for forming low dielectric constant insulating film, the method includes a step of using a plasma generated by a dual-frequency RF power source (column 3, line 33) for depositing a dielectric layer. Lee discusses amorphous carbon (column 1, line 60) as a low dielectric layer, he also discusses the advantages of dual frequency in obtaining a thermally stable dielectric.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Rui and Liu to include a dual-frequency power source for generating the plasma used in depositing the amorphous carbon layer because the subsequent step, after depositing and patterning the carbon layer, is to do a metal etch step which requires relatively high process temperature, therefor, a thermally stable hard mask is desirable. One of ordinary skill in the art would have been motivated to include the teachings of Lee to use a dual-frequency source to obtain a more robust hard mask for metal etching.

Claim Rejections - 35 USC § 103

11. Claims 15,19,20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rui et al. (US 20040229470) as applied to claims 1,2,7,8,9,10,15,16,17and 18 above, in view of of Liu et al. (US 20040038537) as applied to claims3,4,5,11,12 and 13 and further in view of Dakshina-Murthy et al. (US 6884733).

The method of Rui modified by Liu, described above, comprises all the steps of applicant's claims 19-21.

A difference is noted between applicant's claims 19-21 and the method of Rui and Liu. Rui and Liu disclose oxynitride as the material used for the ARC layer and fail to disclose any of the materials cited by the applicant for the same purpose, namely silicon nitride, silicon carbide, c-doped silicon oxide or amorphous carbon.

Dakshina-Murthy discloses a use of amorphous carbon mask for gate patterning to eliminate requirement of poly re-oxidation. The method includes depositing an amorphous carbon layer on top of a conductive layer for use as a hardmask as claimed by the applicant in claim 9, the method also includes the step of depositing a silicon nitride layer as an ARC layer (column 7, line 10) on top of the amorphous carbon material.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Rui and Liu to include a silicon nitride material as the ARC layer because silicon nitride is a well known and understood

material in semiconductor processing. One of ordinary skill in the art would have been motivated to use silicon nitride as an ARC layer because it is a material used in other processing steps such as gate electrode material, thus minimizing process and equipment complexity in a manufacturing environment.

Claim Rejections - 35 USC § 103

12. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Rui et al. (US 20040229470) in view of Liu et al. (US 20040038537) as applied to claims 3,4,5 and 11,12,13 above, in view of Dakshina-Murthy et al. (US 6884733), and further in view of Lee et al. (US 6043167).

The method of Rui, Liu and Dakshina-Murthy, as described above, is silent about using a dual frequency RF power source for generating the plasma used in the deposition of the amorphous layer.

Lee discloses a method for forming low dielectric constant insulating film, the method includes a step of using a plasma generated by a dual-frequency RF power source (column 3, line 33) for depositing a dielectric layer. Lee discusses amorphous carbon (column 1, line 60) as a low dielectric layer, he also discusses the advantages of dual frequency in obtaining a thermally stable dielectric.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Rui and Liu to include a dual-frequency power source for generating the plasma used in depositing the amorphous

carbon layer because the subsequent step, after depositing and patterning the carbon layer, is to do a metal etch step which requires relatively high process temperature, therefor, a thermally stable hard mask is desirable. One of ordinary skill in the art would have been motivated to include the teachings of Lee to use a dual-frequency source to obtain a more robust hard mask for metal etching.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahmoud Dahimene whose telephone number is (571) 272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MD